2009 TRB Annual Meeting DVD
Papers related to ongoing WHRP projects

0092-04-15 Bridge Integrated Analysis and Decision Support - Case Histories (Phase II)

Accounting for the Impact of Thermal Loads in Nondestructive Bridge Testing
Jesse D. Sipple and Erin Santini Bell, University of New Hampshire
Paper Number: 09-2002
From: Abstract
Instrumentation and nondestructive testing is a large part of a comprehensive structural health monitoring program. Another key component of structural health monitoring is a finite element model for evaluation of the measured responses through model updating. One method of nondestructive testing is a controlled static load test, where a pre-weighed truck is placed at predetermined locations on the bridge and the response is measured via strain, rotation, and deflection measurements. The truck location, wheel weights, and time at each location are carefully recorded during the entire duration of the load test. However, there is another load that can have more of an impact on the bridge response than applied static load, and that is thermal loading due to temperature change. It has been observed in three different load tests at Rollins Road Bridge in Rollinsford, NH that temperature effects mask the impact of the truck load applied to the bridge over the duration of the load test. These temperature effects either need to be removed from the data, using an empirical correction or including in the model. Accounting for thermal and environmental effects on the data using empirical methods allows insight into structural response caused solely by applied loads. This in conjunction with a predictive structural model allows the user to get an accurate representation of the bridge behavior to determine the current structural health of the bridge and predicts the response of the bridge to future load conditions. This paper presents a research project currently funded by the Research Advisory Council of the New Hampshire Department of Transportation to develop a framework for bridge condition assessment integrating instrumentation and structural modeling for highway bridge decision-making and management.

Complementary Condition Assessment of Bridge Decks by High Frequency GPR and Impact Echo
Nenad Gucunski and Carl Rascoe, Rutgers; Robert Parrillo and Roger Roberts, Geophysical Survey Systems Incorporated
Paper Number: 09-1282
From: Introduction and Abstract
It is imperative that methods used in bridge deck condition assessment be accurate, rapid, and nondestructive. The current practice of using the human ear for deck inspection by chain dragging or hammer sounding provides rapid and nondestructive evaluation. However, their accuracy is significantly compromised by the fact they can be used only to identify delaminations at stages where the deterioration has already progressed to such an extent that minor rehabilitation or preventive maintenance is not an option.

Geophysical methods, ground penetrating radar (GPR) and impact echo (IE) in particular, successfully overcome the limitations of chain dragging and hammer sounding. GPR excels in its ability to detect early signs of bridge deck deterioration and potential for delamination, while IE in its ability to detect and quantify the degree of delamination.

The current practice of GPR bridge deck condition assessment is based on identification of deteriorated sections of the deck from the attenuation of radar reflections from the top layer of rebar. While typical bridge deck delaminations are not visible in GPR scans, the higher the attenuation, the higher is the potential for deck delamination. On the other hand, IE does not provide much information about the material deterioration, but it enables detection of delaminations as reflectors within a bridge deck.

The presented work had two primary objectives. The first objective was to compare results of a bridge deck condition assessment by three high frequency air (horn) and ground coupled GPR antennas. The second objective was to further explore complementary usage of GPR and IE in bridge deck evaluation.

Results of a comparative study of application of three high frequency GPR antennas are presented.

GPR attenuation maps are also compared to the IE condition assessment maps, demonstrating benefits of complementary use of GPR and IE bridge deck evaluation and monitoring.

Effects of Environmental Variables on the Infrared Imaging of Subsurface Features in Concrete Bridges

Glenn Washer, Richard Fenwick and Naveen Bolleni, University of Missouri; Jennifer Harper, Missouri Department of Transportation

Paper Number: 09-3840

From: Introduction

Infrared thermography is a widely utilized nondestructive evaluation (NDE) technology for the condition assessment of materials and structures (Yehia et al. 2007). The method generally involves the use of a specialized camera that is sensitive to electromagnetic radiation (photons) in the infrared (IR) range to infer the surface temperature of a material.

However, the method relies upon the ambient environmental conditions surrounding a bridge to provide thermal variations necessary for detection. As such, the effectiveness of the method varies as a result of environmental conditions that cannot be controlled, leading to uneven performance in the field (Chong et al. 2003).

The research reported here investigates the environmental conditions that affect the detectability of subsurface features in concrete, in an effort to develop specific and quantitative guidelines for the application of infrared thermography. The guidelines being developed are intended for providing guidance on the optimum conditions for thermographic inspections of concrete bridge element including decks, main member, piers and abutments.

Interstate-80 Corridor GPR Bridge Assessments: Deterioration Mapping of Asphalt- and Polymer Concrete-Overlaid, Reinforced Concrete Decks – Elko County, Nevada

Francisco A. Romero, Underground Imaging Technologies; Michael Premo, HDR Engineering; David Severns, Nevada Department of Transportation; John G. Diehl, GEOVision Geophysical Services, Inc.

Paper Number: 09-3472

From: Project Scope and Survey Methodology; Abstract

GPR collects detailed bridge deck information rapidly, comprehensively and inexpensively compared with other NDE and destructive sampling methods yielding comparable deck coverage. Furthermore, it enhances accuracy of deterioration quantity estimates when used with complementary NDE or physical/chemical sampling including coring, chloride testing, etc.1 This is true on larger structures in congested or urban areas where it’s difficult to collect enough NDE or physical samples and when highspeed traffic or road geometry prevents extensive evaluation behind lane closures. On long stretches of highway with heavy truck traffic work zone safety becomes a critical consideration: drivers react slowly to rapidly changing roadway conditions as driving becomes monotonous and traffic typically exceeds speed limits.

GPR surveys of asphalt-overlaid, reinforced concrete decks were performed on 14 bridge structures along Interstate-80 in Elko County, Nevada. A thin polymer concrete (PC) overlay initially applied to the bare concrete was later overlaid with asphalt. GPR analysis quantified upper deck deterioration on maps used to identify advanced concrete degradation.